Vertical Structure of Neptune's Atmosphere

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The first images of Neptune taken with the Hubble Space Telescope (HST) Wide Field Planetary Camera 2 (WFPC2) on 28 and 29 June 1994 revealed several changes in that planet's atmosphere since the Voyager 2 flyby in 1989. In particular, they showed that the Great Dark Spot had vanished, and that a planet-encircling cloud band had formed in the northern hemisphere near 30 N Latitude. Subsequent observations (Hammel *et al.* *Science* **268**, 1740, 1995) revealed rapid variations in the discrete cloud features and the appearance of a new dark feature near 30 N Latitude. The latest HST WFPC2 observations acquired by our team on 13 and 14 September 1995 show bright cloud features in both hemispheres, but no evidence of dark spots. These imaging observations are also providing new constraints on the vertical structure of Neptune's atmosphere. We used an atmospheric radiative transfer model to estimate the relative altitudes of features in Neptune's atmosphere. The model employs a 40-level, 16-stream, multiple scattering model based on the discrete ordinate method (Stamnes *et al. Appl. Optics*, 27, 2502, 1988) and a monochromatic description of the gas and aerosol optical properties to generate synthetic radiance spectra for comparison with WFPC2 images. Acceptable fits to the observed geometric albedo spectra were obtained for a wide range of aerosol distributions. All simulations produced a few surprising results, however. In particular, we found no compelling evidence of an optically-thick planet-wide H_2S cloud at pressures >3 bars. When this cloud was omitted, the wavelength-dependent albedo and center-to-limb brightness of Neptune's disk could best be simulated by a Rayleigh-scattering H_2-He atmosphere with a spatially-uniform, optically-thin (τ (0.75μm) $\sim$0.1), stratospheric (<3 mbar) haze layer and a latitude-dependent, optically-thin (τ <0.1), tropospheric haze layer confined between $\sim$0.3 and 1.5 bars. The discrete, bright clouds also appear to be confined between 1 and 2 bars. Rayleigh scattering by the H_2/He atmosphere may provide all of the scattering needed between 2 and 10 bars, but a diffuse haze cannot be precluded there.